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Infant Mortality in Kenya: Evidence from the Kenya Fertility Survey

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Preface

It is now generally acknowledged that Kenya has one of the highest growth rates in the world, perhaps four per cent a year. At this rate, the population of the country will double in about 17 years. Whenever this growth rate is considered, there is a tendency to concentrate on the fact that Kenya has an extremely high birth rate. What is neglected is that the recent increase in the growth rate is mainly caused by declines in mortality. The pace of this mortality decline is in many ways as striking as the persistence of, or even slight increase in, the high fertility level.

This paper suggests that while the decline in mortality over the preceding decades has been considerable, much remains to be done in the field of health and medical resources and nutrition. The chances of survival for infants from different socio-economic backgrounds or geographic areas still differ considerably. Indeed, infant mortality rates even in the more favoured segments of the society are still well above those in developed countries. One implication of this report is that further increases in educational attainment and improvements in rural health services may substantially reduce overall infant mortality. Perhaps most importantly, a reduction in the number and proportion of large families would also have substantial impact on infant mortality.

This paper utilizes infant and child mortality information from the birth history data of the Kenya Fertility Survey. This data set is a uniquely valuable resource for estimating not only current levels of infant mortality, but also the magnitude of changes in infant mortality levels over the past few decades (Kenya Central Bureau of Statistics 1979a). The author acknowledges the assistance of the Central Bureau of Statistics and the World Fertility Survey in making these data available, and also wishes to thank Ms Linda Werner of the Central Bureau of Statistics and Ms Ailsa Korten of the Population Studies and Research Institute for their outstanding programming assistance. Finally the editorial and substantive assistance of Susan Mott is acknowledged with thanks.

Biographical note

Frank Mott who is Associate Project Director for the Center for Human Resource Research at Ohio State University, prepared this report while he was a Population Council Visiting Professor at the Population Studies and Research Institute at the University of Nairobi between March 1979 and March 1980.

1 Introduction

Whether gauged by psychological, social or economic criteria, the death of an infant or small child represents one of the most costly of human experiences. Every human birth is a unique event and the cost of the death of a child to the family and friends in psychological terms is, of course, inestimable. From a social perspective, a high infant death rate colours the attitudes of a whole society regarding the 'value of a child'. A society hesitates to place too high a value on a new human life which, at best, has an uncertain probability of reaching adulthood. Finally, the economic cost of a prematurely terminated life is considerable; for example, the nutritional, health and medical resources spent on a child who does not live past early childhood are largely wasted resources.

Reflecting its intermediate position on the world development scale, Kenya has a mortality level which is more or less midway between the extremely high mortality of some African countries and the low mortality levels of the developed nations. However, available data for a thorough examination of the level of mortality for most developing societies are limited. In addition, interpretation is difficult because overall estimates of infant and child mortality mask major variations within a heterogeneous society such as Kenya. For example, an overall infant mortality rate for Kenya disguises the fact that there are major mortality differentials within the country by socio-economic status and geographical location. As this paper suggests, there are major differences in infant mortality between infants whose mothers have more and less education, who live in different parts of Kenya or who live in rural as against urban areas. These differences reflect such factors as differential access to health care, basic nutrition and knowledge about child care. To the extent that area of residence and level of education represent useful proxies for these different factors, one objective of this paper is to examine the independent effect of these and other potential explanatory variables on current and past levels of infant mortality.

1.1. OBJECTIVES OF THE RESEARCH

This research has two primary objectives. First, to estimate the general level of infant mortality in Kenya and to show how this level varies between the different socio-economic strata and geographic areas of the country. Secondly, the extent to which infant mortality levels and differentials have changed over time will be examined. It should be emphasized that declines in infant mortality may reflect two basic phenomena: declines *within* specific socio-economic or geographic subgroups as well as shifts within the population structure leading to an increase in the proportion in the 'low mortality risk' groups. For example, a decline in infant mortality may result from a decline within each educational subgroup as well as from the decline resulting from an overall rise in the level of education of the whole population: the children of better educated women, everything else being equal, are more likely to survive.

On a cautionary note, it is important to emphasize that, given the uncertain quality of the mortality data in the Kenya Fertility Survey, the estimates are subject to a margin of error. The overall infant mortality estimates suggested for Kenya reflect a series of adjustment procedures, and, in the view of the author, are reasonable estimates for infant mortality in Kenya in the 1970s. However, the data presented in subsequent chapters, which focus on an examination of differentials between population subgroups, have not been refined to the same extent. It is felt that the nature of the differentials would not be significantly affected by these adjustments. In any event, the purpose of the later chapters is to suggest the patterns and approximate magnitudes of the socio-economic and geographic differentials, now and during the past few decades, rather than the best estimates of levels of infant mortality for subgroups of the population.

1.2. A BRIEF REVIEW OF AFRICAN DATA ON INFANT AND CHILD MORTALITY

Data on infant and child mortality for sub-Saharan Africa is, at best, of uneven quality and inconclusive, and, at worst, grossly inaccurate. The unevenness of data quality reflects largely the limited availability of large-scale survey data for estimating, either directly or indirectly, current mortality levels. In addition, for most African areas, usable

Table 1 Estimated Infant Mortality Rates and Per Capita Gross National Product (US Dollars) for African Countries with Populations of over 10 000 000

	1MR[a]	GNP per capita
Ethiopia	162	110
Zaïre	160	130
Nigeria	157	420
Algeria	142	1100
Sudan	141	300
Mozambique	140	150
Uganda	136	260
Morocco	133	570
Tanzania	125	200
Ghana	115	380
Egypt	108	310
South Africa	92	1340

[a]Infant deaths per 1000 life births.
Source: Population Reference Bureau Inc 1979

historical estimates do not exist. Finally, for a number of reasons, data on infant and child mortality are often suspect, as we discuss in the following chapters.

In general, infant mortality rates and post-neonatal infant mortality are among the best indicators of socioeconomic development. Infant mortality levels in Africa run the gamut from among the highest in the world to, more rarely, relatively low rates. Table 1 gives estimates of infant mortality and per capita gross national product for the larger countries of the African continent. Bearing in mind that these estimates may be subject to error, it nevertheless appears that there is an inverse association between infant mortality levels and economic well-being, particularly if one makes an adjustment for the fact that the real well-being of the population of some of the countries is overstated by the inclusion of large oil revenues in the gross national product.

Population Reference Bureau estimates for all African countries in 1979 show clearly how infant mortality rates on the continent are distributed on the high side of the world mean. The Bureau estimates that overall infant mortality for the whole world is about 95 infant deaths per 1000 births. All but five of the 52 African nations for which data are available have estimated infant mortality rates above this level. Indeed the summary of these estimates in table 2 suggests that average infant mortality in Africa is above 140 infants per 1000 births. (There can, of course, be disagreement between professional demographers about the reliability of the estimated infant mortality rates. Indeed, the results of this study suggest that the PRB estimate for Kenya may be somewhat high. The data are none the less useful for suggesting the general orders of magnitude and range of infant mortality in Africa.)

Of course, these aggregate figures mask significant differentials between different groups and geographic areas within countries. There is a growing literature on mortality differentials in Africa which suggests several generalizations, but leaves unanswered several important questions. There is a consensus that increasing educational attainment of the mother is associated with declines in infant mortality (Caldwell 1979; Anker and Knowles 1977; Brass 1979). This inverse association has been attributed to many causes. These include the likelihood that education is associated with: (1) breaks with the traditional family methods of child care; (2) less fatalism about illness; (3) more effective child care and medical alternatives; (4) better nutritional use of available foods; and (5) more personal and intensive attention by the mother with a greater share of the family resources spent on the child.[1]

Table 2 Distribution of All African Countries by Level of Infant Mortality

Total	52
Under 100	6
100–119	6
120–139	9
140–159	12
160–179	11
180 and over	8

Source: Population Reference Bureau Inc 1979

Polygamy in some instances has also been found to be associated with above-average levels of infant mortality (Caldwell 1979), as are births of parity one as well as very high parity births. High parity risk is also exacerbated if the births are spaced closely together. However, even a relatively low parity birth (eg a third child) runs a high risk of dying if it occurs soon after the second birth (Pringle *et al* 1969). One other common finding is a significantly higher infant death probability among male births (Anker and Knowles 1977; Page 1971; United Nations 1979).

Of considerable interest is the ambiguity of the relationship between infant mortality and urban residence. The evidence in this regard is quite unclear. While there are considerable data indicating an inverse association between urban living and lower infant mortality (United Nations 1973; Page 1971; Gaisie 1979b), it now appears likely that this inverse association does not reflect urban or rural residence *per se* but other factors associated with them. Indeed, there now are a number of studies which suggest no significant inverse association between urban residence and infant mortality within a multivariate context; in other words, other factors such as education, marital status and family size may be the underlying factors which account for urban-rural differentials (Caldwell 1979; Anker and Knowles 1977).

Another important area of investigation concerns the distribution of infant deaths within the first year. Early infant deaths, particularly those during the neo-natal period (first four weeks), are dominated by factors essentially related to the birth process itself or affected heavily by congenital phenomena. As the infant ages, increasing proportions of deaths are associated with 'exogenous' causes, factors related to the environment in which the infant lives (Conde and Boute 1971; Clairin 1968; United Nations 1973: 126; Cantrelle 1971). Thus, external health and nutritional factors become increasingly important in determining the survival chances of older infants. To the extent that these environmentally based death causes are more prevalent in developing societies, one ordinarily anticipates that the lower the level of development in a country, the greater the proportion of infant deaths which occur after the neo-natal period. Conversely, for this reason, the percentage of infant deaths which may be classified as post-neonatal may be utilized as one of the better indices of health development. Table 3 indicates the strength of this association by providing the percentage of infant deaths which are post-neonatal and the infant mortality rate for a full range of countries in the world over the last 15 years. It is evident from this table that declines in infant mortality are directly associated with a shift towards larger percentages of infant deaths occurring during the first month. This knowledge of the expected association between infant mortality and post-neonatal mortality can be useful from both a substantive and methodological viewpoint. Substantively, the relationship between different population subgroups within Kenya may be a useful indicator of relative internal stages of development and will be considered in this way within this paper (Gaisie 1979a). Methodologically, unusual

[1] Caldwell (1979) discusses these and other possible factors affecting the relationship between education of mother and father and the probability of an infant death.

Table 3 Infant Mortality Rates and the Percentage of Infant Deaths which Are Post-Neonatal for Selected Countries in the World

	Year	IMR	% of infant deaths, post-neonatal
Sweden	1975	8.6	25.5
Japan	1975	10.0	32.4
USA	1974	16.7	26.6
Cuba	1971	37.4	37.7
Argentina	1970	58.9	58.4
South Africa (coloured)	1971	102.3	67.3
Togo	1961	127.0	66.2
West Cameroon	1964-5	137.2	53.8
Chad	1963-4	160.1	61.4

NOTE: See footnotes to table 15 in the 1976 *Demographic Yearbook* for further detail regarding the limitations of these rates.

Source: United Nations 1977

or unexpected relationships between neo-natal and post-neonatal infant mortality may be a useful indicator of possible misstatement of age at death within the first year.

1.3 HISTORICAL DATA ON MORTALITY IN KENYA

The earliest rates of mortality for Kenya were estimated from crude data that were often collected for other than demographic purposes. Early direct attempts to measure mortality were also inadequate and probably understated mortality levels.

In the last century, slave raids and tribal wars claimed many lives, but, from a demographic point of view, famines were the most severe causes of death. Fifty per cent of some tribes were estimated to have died in the famines between 1898 and 1900. There is little indication that the general standard of health had improved by the early 1900s. Sleeping sickness, malaria, plague and malnutrition still threatened the African population (Kuczynski 1949: 190–201). Though there were no direct estimates of infant mortality in this period, we can safely assume that infant mortality levels were extremely high, perhaps 500 per 1000 births.

Between 1922 and 1933 several sample surveys were taken in an attempt to arrive at some direct measures of infant mortality (Kuczynski 1949: 212–15). A survey in the Central Kavirondo District in 1922 suggested that 413 infants per 1000 died in the first year of life. This estimate was used by the Principal Medical Officer to represent the level of infant mortality throughout the colony of Kenya. A similar survey was taken in Kisumu in 1925, 1926 and 1927 and indicated infant mortality rates of 118, 277 and 237 respectively. Here the lower rates were attributed to improved housing (provided by the Uganda Railway) and the fluctuations were thought to be due to the varying incidence of malaria during the survey years. In 1931, a survey among the Masai indicated that of 2817 children born to 907 women, 1260 had died. Information on age at death was not collected so it was impossible to construct an infant mortality rate. The Medical Department summarized the results of the various surveys taken between 1922 and 1933 by estimating that between 10 and 14 per cent of African infants died before reaching age one. The data were too scanty to be conclusive and probably understated mortality levels. In fact, the Acting Director of Medical and Sanitary Services used the figure of 500 infants deaths per 1000 in testimony before the Land Commission.

By the time of the 1948 census, Kenya had entered the demographic transition and mortality levels had started to decline. The census estimate of infant mortality in the first year of life was 184 per 1000. Since many mothers thought in terms of weaning (roughly at age two) rather than in terms of years of age, the definition was later revised and this same mortality estimate was assumed to apply to children up to two years of age (Herz 1974: 271). This estimate was considerably lower than the possible 400 or 500 per 1000 estimated from the earlier surveys.

Available evidence suggests that mortality has continued to decline sharply since 1962 (Kenya Bureau of Statistics 1966; Kenya Central Bureau of Statistics, ND; Blacker 1979; Henin and Mott 1979). The crude death rate was established at between 18 and 23 per 1000 in the 1962 census, at 17 in the 1969 census, and at 14 in the 1977 National Demographic Survey (NDS). Life expectancy at birth rose from an estimated 40–45 years in 1962 to 46.9 years for males and 51.2 years for females in 1969. Estimates from the NDS in 1977 suggest a further rise in life expectation at birth to 51.2 years for males and 55.8 years for females (Blacker 1979).

Paralleling the decline in general mortality, infant mortality rates also appear to have declined sharply. The 1962 census estimated that 174 out of every 1000 babies born died in the first two years of life. By 1969 deaths in the first two years of life were estimated at 157 per 1000 and deaths in the first year of life at 119 per 1000.

Preliminary information from the NDS in 1977 indicated that infant mortality in the first year has declined substantially in the intervening eight-year period (Blacker 1979).

2 Trends and Levels of Kenyan Infant Mortality

2.1 METHODOLOGICAL CONSIDERATIONS

A number of explanations have been put forward for the poor quality of infant death records, amounting to the suggestion that either infant births and deaths are underreported or that ages at death are misreported. This latter problem can result in a misplacement of a death either earlier or later in the first year than it actually occurred or the transferring of a young child's death either into or out of the first year.

The total failure to report a birth and a subsequent infant death is perhaps the most difficult error to identify. This omission would lead to an understatement of the infant mortality rate and is generally considered to be a problem most prevalent in the reporting of infant deaths which occurred in the distant past and have been forgotten, or of deaths which occurred in the very recent past where an intentional omission may be psychologically based. Indeed, it has been suggested that 'infants, who have not yet attained social importance, may be omitted from all statistics if they die' (Cantrelle 1975: 103). Also, the younger the child at the time of death, the greater the likelihood of omission. Thus, it is likely that misreporting of this kind would be revealed in the statistics as an unusually low neonatal death rate. Although it has never been clearly documented, it is also possible that retrospective infant mortality reporting among older women may be understated to the extent that women who have above-average mortality probabilities themselves may be more likely than other women to have had infant deaths (Clairin 1968; Brass 1975: 56).

The other major kind of misreporting of infant deaths is the shifting of the deaths backwards or forwards within the early months or years of life. It is generally assumed that misreporting of this kind is associated with births and early childhood deaths in the more distant past, although it may also affect more recent reporting, particularly among population subgroups of limited education or where the reporting is being done by someone other than the mother. Heaping of infant deaths at one year (often reported as 13 months after birth in a survey) or at six months is quite prevalent. Finally, there may be some tendency to report deaths which occur early in the second year as being infant deaths, particularly where a child has not yet been weaned. It may be noted that these causes of misreporting may to some extent cancel one another out, as in some instances second-year deaths may be reported in the first year and in other instances first-year deaths may be reported in the second year.

2.2 THE LONGER-TERM TREND IN INFANT MORTALITY

Before focussing specifically on a 'best estimate' of current infant mortality in Kenya, we will consider a somewhat broader sweep and utilize the Kenya Fertility Survey birth history records to examine trends over the last decades.

While the data do not permit construction of a complete series of infant mortality rates for women of all ages and parities for any but the last decade, it is useful to compare approximately comparable subsets of women for different historical periods.

Thus, limiting the comparison to women below the age of 35, an age range which includes most births as at the decade end points, it may be seen in table 4 that the trend is quite pronounced and consistent across age groups.

Declines in infant mortality in Kenya were steep in the 1950s and 1960s and somewhat more modest (though still significant) since then, a trend most pronounced in the youngest age group of women. Births in the twelve-month period preceding the interview for a particular woman are excluded in table 5 and throughout the analysis. More precisely, the three periods are 13 to 119 months, 120 to 239 months and 240 months or more preceding the interview. Very roughly, the intervals are taken as 1968–76, 1958 -67 and pre–1958 respectively.

Table 5 shows the trend in infant mortality decline separately for the first three birth orders. Reasonably confident comparisons over the period under review can only be made for the first three birth orders as the oldest women (45–49 years) in the study were approximately 25–29 20 years ago. By that age, the large majority of those who ever attained three births had reached that parity level. Thus, the comparison in the table probably does not include any significant bias because of the inclusion of incomplete parity cohorts. It may be noted that the largest declines in infant mortality on a parity-specific basis generally occurred between the 1950s and 1960s. In addition, this pattern was most pronounced for infant deaths to first-born children. Since births and deaths in the more distant past are more likely to be forgotten (Brass 1975), the decline in infant mortality over time noted in this report may actually be an understatement.

Let us consider briefly the extent to which the historical trend may reflect differential reporting biases between the earlier and later period. First, to what extent was heaping at one year more significant in the more distant past? Table 6 distributes the reported infant deaths over the first 13 months of life between the three periods under consideration.

Table 4 Infant Mortality Rates by Period of Birth and Age of Mother at End of Period

Age of mother at end of decade	Period of birth 1968–76	1958–67	Pre-1958
15–19	106.9	122.3	198.2
20–24	108.7	117.2	180.7
25–29	88.8	113.2	143.4
30–34	83.9	90.6	152.1
35–39	81.7	101.5	–
40–44	81.1	–	–
45–49	106.9	–	–
15–34	92.1	109.1	158.8

Table 5 Trends in Birth Order Specific Infant Mortality, by Period of Birth and Current Age of Mother

Current age of mother	Period of birth 1968–76	1958–67	Pre-1958
Birth order one			
15–19	116.1 (310)		
20–24	107.7 (1012)		
25–29	100.3 (897)	122.4 (482)	
30–34	71.4 (140)	131.0 (809)	
35–39		128.0 (578)	192.3 (286)
40–44		118.4 (152)	205.1 (429)
45–49			179.7 (551)
50			180.6 (72)
Birth order two			
20–24	116.6 (654)		
25–29	75.1 (1065)	109.3 (183)	
30–34	64.9 (339)	96.0 (604)	
35–39		96.3 (675)	186.4 (118)
40–44		113.6 (264)	135.1 (296)
45–49			130.3 (491)
50			166.7 (66)
Birth order three			
20–24	100.6 (308)		
25–29	78.9 (950)		
30–34	68.8 (509)	127.6 (384)	
35–39	103.4 (145)	98.0 (663)	
40–44		59.5 (353)	181.3 (171)
45–49		61.2 (196)	126.0 (373)
50			175.4 (57)

NOTE: Numbers of births are given in parentheses.

A careful examination of the distribution of infant deaths by single months suggests that, for a country at Kenya's intermediate level of development, no more than 25 per cent of the infant deaths should occur in the second half of the first year, or about 4 per cent in any given month. Any modest errors in this estimate will not change the substance of the conclusion reached. If this conclusion is even approximately true, then the 8 per cent excess deaths in month 13 might be evenly distributed between the earlier (month 12) and the later (month 14) and the infant mortality estimates in the earlier table might be increased by approximately 4 per cent to about 96 (last 10 years), 114 (10–19 years) and 165 infant deaths per 1000 births (20 and more years ago), respectively.

Of course, it should be borne in mind that the data suggest biases of the same magnitude for all three time periods under consideration. Thus, the earlier suggested historical trend in infant mortality is not affected substantially by heaping at 13 months.[2]

[2] The adjustments in this section are primarily for illustrative purposes. It was not considered feasible or necessarily appropriate to make comparable adjustments for all the infant mortality rates which follow in this report.

Table 6 Distribution of Children who Died in the First 13 Months, According to Age at Death, by Period of Birth

Period of birth	Deaths 1–12 months	Deaths in month 13	Total deaths	Percentage in month 13
1968–76	1385	181	1566	11.6
1958–67	1091	170	1261	13.5
Pre–1958	599	86	685	12.6
Total	3075	440	3515	12.5

As also suggested earlier, it is possible that for earlier periods there may have been some telescoping of second-year births into the first year. A testing of this hypothesis makes use of the generally accepted notion that if the data are completely accurate, second-year deaths, as a percentage of year one plus year two deaths, should be higher for deaths further in the past than for more recent years. This is because exogenous deaths should make a smaller contribution to early childhood deaths now than in the past. The general trend in the distribution of deaths between the first and second year may be noted in table 7 where the child death distribution over the first two years of life may be seen for the subset of first to third order births for women in three different current age groups. Consistent with expectation, neo-natal deaths form a greater proportion of the first two years' deaths for younger women whose babies were born in the recent past. However, there are no significant differences between the three age groups in the percentage of deaths which occurred during the second year of life. This suggests that there may have been a greater tendency for second year deaths in the more distant past to be shifted into the first year. Without attempting to quantify the significance of this factor, it is suggested that the net impact of any adjustment would be to lower the infant mortality rate for the older cohorts compared with the younger ones and *reduce* the trend in infant mortality between the three periods under consideration.

Table 8 shows in somewhat greater detail the extent to which infant mortality has been declining over the years. In general, for the same parity, infant mortality increases with age of mother. This pattern, as already indicated, is most pronounced at the lower birth orders. The principal exception to the generalization is where women are giving birth to children at ages which are premature for that parity level (Pringle 1969: 301). For example, sixth or seventh births below the age of 30 and eighth births below the age of 35 are premature births in the sense that spacing for that and preceding births for those women has probably been unusually tight, resulting in above-average probability of inadequate nutrition and child care.

2.3 THE CURRENT INFANT MORTALITY RATE IN KENYA

Current estimates of infant mortality in Kenya have been derived both directly from the infant mortality information in the KFS birth history data and indirectly, by applying the Brass techniques to child survival data for women 15–19 years of age at the survey date. All of the available rates are summarized in the following text table and discussed below:

	Infant deaths per 1000 births
Brass indirect estimates	
1 Using $\frac{P1}{P2}$ and standard adjustment	90
2 Using $\frac{P2}{P3}$ and standard adjustment	88
3 Using $\frac{P1}{P2}$ and Africa adjustment	87
4 Using $\frac{P2}{P3}$ and Africa adjustment	84
Direct estimates	
1 Covering the 1973–6 period (unadjusted)	83
2 Covering the 1973–6 period (adjusted)	87
Blacker (1979) estimate	
(based on National Demographic Survey)	83

Table 7 Distribution of Children of Birth Order One, Two and Three who Died in the First Two Years, According to Age at Death, by Current Age of Mother

Current age of mother	Frequencies					Percent distribution					Year two deaths as percentage of year one plus year two deaths
	First month	Months 2–12	Months 13	Months 14–24	Total	First month	Months 2–12	Months 13	Months 14–24	Total	
20–29	253	298	69	82	702	36.0	42.5	9.8	11.7	100.0	21.5
30–39	259	345	89	78	771	33.6	44.7	11.5	10.1	100.0	21.6
40–49	170	305	63	50	588	28.9	51.9	10.7	8.5	100.0	19.5

Table 8 Infant Mortality Rates by Birth Order and Current Age of Mother

Current age of mother	First birth	Second birth	Third birth	Fourth birth	Fifth birth	Sixth birth	Seventh birth	Eighth birth	Ninth birth	Tenth to fifteenth birth
15–19	116	–	–	–	–	–	–	–	–	–
20–24	109	111	101	99[a]	–	–	–	–	–	–
25–29	108	80	84	90	76	150[a]	151[a]	–	–	–
30–34	125	89	94	76	95	95	100	139[a]	–	–
35–39	147	105	106	94	97	80	104	109	88[a]	97[a]
40–44	183	125	96	101	93	86	89	89	68[a]	87[a]
45–49	172	118	110	130	102	95	75	109	110[a]	167

[a]Rates based on fewer than 300 births.

The indirect methods utilizing the standard Brass adjustments and the Brass African adjustments provided rates ranging between 84 and 90 infant deaths per 1000 live births.[3] This method essentially utilizes information on survival of children born to 15–19 year old women and is described more completely in appendix A. As most births and deaths to these women were in the fairly recent past, the estimates of infant mortality derived by this method, whatever their limitations, may be considered to be for a recent period. The rates implied by the four adjustments differ mostly in their assumptions regarding the shape of the fertility curve and mortality curve at the early ages of childbearing and cover a fairly narrow range.

The direct estimate of infant mortality from the birth history data, covering approximately the four-year period between 1973 and 1976, was about 83 deaths per 1000 births (births of women in the 12-month period preceding the survey have been excluded. This estimate included 611 infant deaths and 7332 live births). Adjusting this estimate upwards by four per cent to take into account the 13-month heaping noted earlier, we obtain a rate of about 87 infant deaths per 1000 births. Utilizing data from the Kenya National Demographic Survey, Blacker (1979) obtained a rate of about 83 infant deaths per 1000 births. Thus, seven estimates of infant mortality for Kenya all fall within the range between 83 and 90. While further refinements of these data certainly are possible, the scope for improvement is probably limited given the quality of the data and the methodology available, and it is reasonable to conclude that the true infant mortality rate lies within this range, with a midpoint estimate of about 87 infant deaths per 1000 births.

Finally, the overall unadjusted infant mortality estimate from the KFS birth histories for the decade prior to the survey is 90.7 infant deaths per 1000 live births. This covers infant deaths of babies born 13–119 months preceding the survey and includes 1385 infants deaths and 15 263 live births. In the birth histories of women between 1968 and 1976 there is an over-representation of younger women and thus an over-representation of low parity births. This is because over the whole decade the sample included women as young as 15–19 but women 45–49, for example, are only represented as at the decade end point. To the extent that the youngest women have above-average infant mortality risks, the overall decade rate of 90.7 may be a slight over-statement. Excluding the 45–49 year old segment of the sample (from whom data are only available for the second half of the decade), a substantial decline occurs between 1968 and 1976. The infant mortality rate for 15–44 year old women between 1973 and 1976 was 81.0, compared with 96.5 for their counterparts in the period between 1968 and 1972.[4]

On the basis of the rates for women under 35, cited earlier, during the longer periods, it appears that overall infant mortality has declined (after adjusting the various decade rates) from a little over 160 for the period pre-1960, to about 110 for 1958–67 to an adjusted rate of about 94 for the most recent period.[5]

[3] The standard methodology for indirectly estimating mortality during the first year of life is often subject to error, reflecting the instability in the proportions of children born to 15-19 year old women who have died and a preponderance of first order births. In this instance, however, the indirect estimates are relatively consistent with the direct estimates and hence are probably valid.

The range of indirectly derived estimates of deaths during the first two years of life was also extremely narrow, averaging about 130 deaths per 1000 live births, somewhat higher than might be anticipated but approximately consistent with the direct estimate of $_2q_0$ for the 1968–72 period. It is of course possible that some of the reported deaths in the second year were really infant deaths and the infant mortality rates reported may be modestly understated. In addition, some of the apparent over-reporting of second-year deaths probably represents a telescoping of deaths actually belonging in years 3–5 into year 2. There is some evidence that deaths in these ages are under-reported.

[4] The ages are those of the women at the end of the respective four and five-year periods. More precisely, it compares infant death rates for babies born 13–59 months before the survey with rates for those born 60–119 months before the survey.

[5] The ratio of infant mortality for births to women aged 35 and under to total infant mortality for 1968–76 was estimated to be 92.1/90.7 or 1.015. Dividing the under-35 infant mortality rates for the two earlier periods by this ratio produced unadjusted rates for the earlier periods of 107.4 and 156.4. Adjusting further for the approximate four per cent undercount due to the 13-month heaping increases the three period rates to 94.3, 111.7 and 162.7, respectively.

3 Differentials in Infant and Neo-Natal Mortality: Past and Present

3.1 INTRODUCTION

As well as enabling us to estimate past and present levels of infant mortality, the birth history data in the KFS may be utilized to indicate differentials between subgroups of the Kenya childbearing population. This chapter discusses past and present differentials in infant mortality by birth order and sex of child, geographic region, education and type of marriage. Because of recent rapid changes in the socio-economic composition of the population (for example, by education) as well as erratic variations in urban-rural residence and geographic residence from one five-year age group of women to the next, the use of Brass indirect techniques for estimating infant mortality for subgroups was deemed inappropriate and subject to substantial error. For this reason, only direct estimates are discussed in this section. These estimates should be treated cautiously, as retrospective data from different periods in the past may be differentially subject to recall errors. In the discussion which follows we have assumed that the magnitude of potential errors is similar for the different subgroups. If this assumption is valid, the differentials in infant mortality between the population groups which are discussed below should be reasonably accurate.

3.2 DIFFERENTIALS BY BIRTH ORDER AND SEX OF CHILD

The KFS and other sources show that there are significant variations in infant mortality both by the birth order and the sex of the child. Generally, infant mortality is the highest for first births and declines with increasing order up until the sixth birth and then rises continuously with increasing parity (table 9). First births include a disproportionate number of difficult deliveries which may be associated with above-average infant mortality. In addition, a disproportionate number of first births occur to women at ages which are well below the physiological optimum for reproduction. It is also likely that some 'selecting out' takes place at higher orders, and women who have had particular difficulty in bearing children may be less likely to conceive again.

At the higher orders, infant mortality rates rise once again, partly reflecting a shorter average spacing between births for high parity women. This is probably associated not only with poorer nutrition for the infants but also perhaps with poorer health among the mothers. The highest parity women have on average inferior living conditions and are less able to provide their children with appropriate

Table 9 Infant Mortality Rates by Sex of Child and Birth Order

Birth order	Male	Female	Both sexes
1	138.5	125.3	132.5 (5900)
2	104.2	96.4	100.6 (5051)
3	106.0	88.3	97.9 (4289)
4	103.4	88.0	96.6 (3625)
5	94.3	94.5	94.9 (2994)
6	95.7	88.1	91.5 (2384)
7	128.5	57.7	95.4 (1793)
8	89.6	123.9	106.8 (1311)
9	101.7	89.9	94.6 (856)
10	126.0	102.4	116.2 (499)
11	132.4	136.4	134.1 (246)
12+	168.5	135.9	164.9 (188)
Total	110.7	99.0	105.6 (29136)

Summary table	Male	Female	Both sexes
Birth order 1	138.5	125.3	132.5
Birth order 2–4	104.6	91.4	98.6
Birth order 5–9	98.8	91.6	95.7
Birth order 10+	135.9	117.8	130.8

NOTE: Numbers of births are given in parentheses.

Table 10 Neo-Natal Deaths as Percentage of Infant Deaths, by Birth Order and Sex of Child

Birth order	Male	Female	Both sexes
1	45.4 (423)	47.2 (358)	46.2 (781)
2	41.9 (265)	33.7 (243)	38.0 (508)
3	45.1 (233)	26.9 (186)	37.0 (419)
4	45.0 (191)	38.0 (158)	41.8 (349)
5	47.9 (146)	44.2 (138)	46.1 (284)
6	49.0 (102)	30.7 (114)	39.4 (216)
7	50.8 (118)	33.3 (51)	45.6 (169)
8	58.9 (56)	35.7 (84)	45.0 (140)
9	57.1 (42)	45.0 (40)	51.2 (82)
10–11	44.9 (49)	53.7 (41)	48.9 (90)
12–15	66.7 (15)	42.9 (14)	55.1 (29)

	Male	Female	Both sexes
Overall neo-natal death rate	51.5	38.2	44.9
Overall infant death rate	110.7	99.0	105.6

NOTE: Numbers of infant deaths are given in parentheses.

medical care and adequate nutrition.

Table 9 also shows clearly that reported infant mortality rates for males are higher than for females at most parity levels. This is consistent with evidence from a number of other studies. Table 10 indicates that the difference between male and female infant mortality may be entirely attributed to neo-natal mortality. Physiological differences in the capability of male and female infants to survive early infancy largely account for this pattern. Boys have a higher risk of birth injury, breathing difficulties and jaundice. It is also possible that female neo-natal deaths are more likely to be under-reported than male deaths, for cultural reasons.

A more careful examination of infant mortality trends by birth order and age of women suggests that, at all parities, infant mortality (especially neo-natal mortality) is higher for women giving birth in the older generations. Comparisons of infant mortality rates between younger and older women are necessarily limited to the first three orders. Infant mortality rates for orders one, two and three respectively for women below the age of 30 are about 109, 90 and 90, compared with about 152, 106 and 100 for women above the age of 30. As may be noted in table 11, there are substantial differences between the older and younger women in the percentage of infant deaths which are neo-natal. Overall, about 48 per cent of infant deaths to women under the age of 30 are reported as occurring during the first month, compared with 41 per cent of infant deaths to the older women. This excess of neo-natal deaths for younger women occurs to a varying extent at almost every birth order. This pattern is consistent with the general trend towards lower infant mortality, a trend largely reflecting improvements in environmental conditions, such as health, medical care and nutrition, which have helped reduce infant mortality, especially after the first few weeks of life. Indeed, the relative level of post-neonatal to neo-natal infant mortality is perhaps one of the best indicators of socio-economic development, as we mentioned earlier.

Not only are neo-natal infant deaths as a percentage of total infant deaths a useful indicator of development but first-year deaths as a percentage of all deaths in the first two years of life may also serve a similar purpose. In both cases, the earlier deaths are more likely to be endogenously caused, and the later deaths exogenously or environmentally caused. The variations by birth order in both these measures are shown in table 12. For both these indicators, exogenous deaths are more common in the intermediate birth orders, whereas endogenous deaths are more prevalent for first-born children and again at the highest orders.

Table 11 Neo-Natal Deaths as Percentage of Infant Deaths by Birth Order and Current Age of Mother

Birth order	Age 15–29			Age 30 and over		
	Neo-natal deaths	Infant deaths	Percentage neo-natal	Neo-natal deaths	Infant deaths	Percentage neo-natal
1	148	298	49.7	213	484	44.0
2	67	177	37.9	126	331	38.1
3	52	118	44.1	103	302	34.1
4	48	77	62.3	98	273	35.9
5 and over	43	77	55.8	415	939	44.2
Total	358	747	47.9	955	2329	41.0

Table 12 Neo-Natal Deaths as Percentage of Total Infant Deaths and First Year Deaths as Percentage of Year One and Year Two Deaths, by Birth Order

Birth order	Neo-natal deaths as percentage of all infant deaths	Year one deaths as percentage of year one and year two deaths
1	46 (782)	82
2–3	38 (928)	77
4–5	44 (633)	75
6–7	42 (385)	77
8–9	47 (222)	79
10+	50 (119)	82

NOTE: Numbers of infant deaths are given in parentheses.

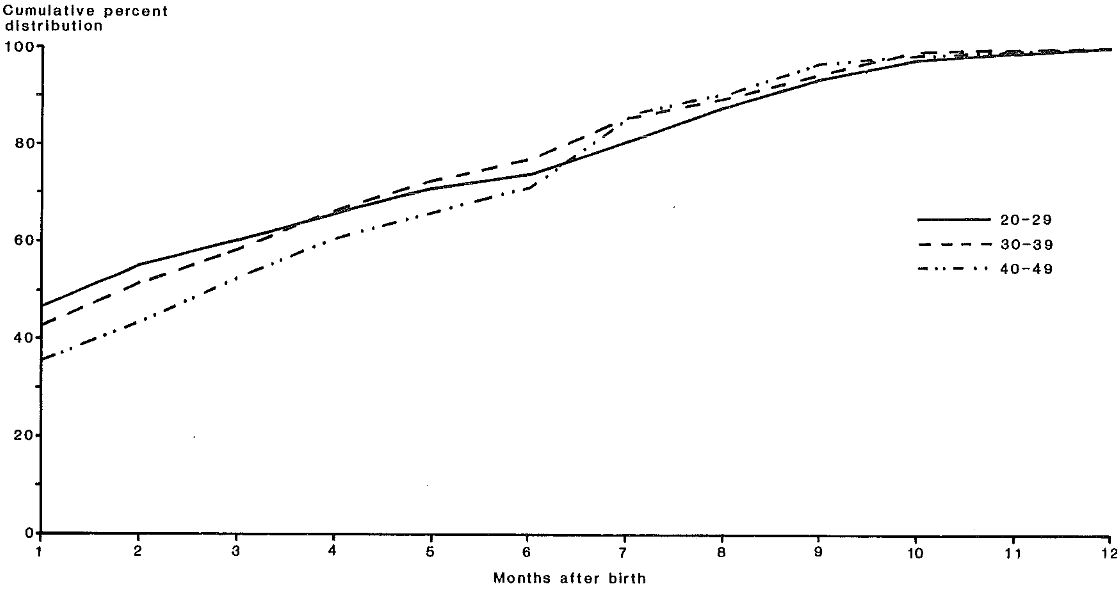

Figure 1 Cumulative Per Cent Distribution of Birth Order One, Two and Three Infant Deaths by Current Age of Mother and Months after Birth

Whether this variation in the age pattern of mortality by birth order truly reflects endogenous factors, such as birth weight, requires further investigation.

Finally, the historical transition towards a greater proportion of endogenous deaths is shown clearly in figure 1, which includes cumulative per cent distributions of infant deaths (at parities one to three) for women of different ages. The figure indicates that younger women have significantly larger percentages of their infant deaths occurring earlier in the first year. It is only later in the first year, when age heaping and age misreporting become more pronounced, that the pattern becomes more ambivalent.

3.3 EDUCATIONAL AND URBAN-RURAL DIFFERENTIALS

The literature on infant mortality includes ample evidence to show a strong inverse association between infant mortality and level of education, both at the individual and ecological level. As table 13 indicates, the gross patterns of association between these variables show that this is also the case in Kenya. The babies of women with more education suffer lower infant mortality than the babies of those with less education. Better educated women are less likely to have their births at the very young high-risk ages, and a tighter control of age might show narrower educational differentials. The lower infant mortality among the more recent birth cohort reflects, at least partly, the increasing education of the Kenyan female population.

It is important to note that older women evidence much lower infant mortality than younger women at the secondary school level and slightly lower infant mortality at the primary education level. Infants of younger women only have lower infant mortality risks if their mother has not completed any education. The overall lower infant mortality rate for infants of women below the age of 30 reflects the combined influences of their lower rate within the no-education group and the fact that only about 42 per cent of that group have no education, compared with 65 per cent

Table 13 Infant Mortality by Educational Attainment, Current Urban-Rural Residence, Current Province of Residence, Current Age of Mother and Birth Order

	Total	Mother's age <30	Mother's age 30+	Total birth order 1–3	Mother's age <30 birth order 1–3	Mother's age 30+ birth order 1–3
All	106 (28504)	98 (7561)	109 (20943)	111 (15013)	98 (6028)	119 (8985)
Education						
No education	117 (16784)	111 (3142)	119 (13642)	127 (8267)	111 (2451)	134 (5816)
Primary	90 (10924)	93 (3845)	88 (7079)	96 (6123)	94 (3075)	97 (3048)
Secondary or higher	57 (796)	65 (574)	36 (222)	55 (623)	60 (502)	33 (121)
Residence						
Urban	89 (2440)	83 (1086)	93 (1354)	87 (1526)	83 (887)	91 (639)
Rural	108 (26101)	101 (6480)	110 (19621)	114 (13504)	101 (5146)	123 (8358)
Province						
Nairobi	82 (1004)	74 (434)	87 (573)	76 (619)	75 (359)	77 (260)
Central	72 (4536)	57 (972)	76 (3563)	84 (2335)	64 (793)	95 (1542)
Coast	140 (2181)	118 (778)	152 (1404)	127 (1266)	114 (603)	139 (663)
Nyanza	147 (6820)	138 (1604)	148 (5218)	161 (3370)	136 (1255)	176 (2115)
Rift Valley	80 (5119)	75 (1534)	82 (3586)	86 (2812)	74 (1229)	95 (1583)
Western	114 (3957)	118 (1112)	110 (2845)	119 (2036)	116 (880)	121 (1156)
Eastern	89 (4876)	87 (1098)	89 (3776)	95 (2565)	91 (891)	97 (1674)

NOTE: Numbers of births are given in parentheses.

for their older counterparts. The data suggest that infant mortality may indeed be lower among the older better educated women because low parity births among the older women included a smaller proportion of births to very young women. This is because a disproportionate number of the younger educated women are not yet mothers but will become so in the future, when they are older. In contrast, older educated women have had greater exposure to risk of childbearing and are nearly all mothers.

Looking again at the distribution of deaths within the first year, it appears from table 14 (though the figures have large sampling errors) that, for older women, the infant deaths of the better educated are more likely to occur in the neo-natal period. Also, the younger women have a slightly larger proportion of neo-natal deaths than the older women, after controlling for educational differences. Thus there is a shifting in the pattern of infant mortality over time as a result of improvements in health services and nutrition, a trend which is being strengthened by the rising level of education.

An examination of infant mortality by current urban-rural residence reveals pronounced differentials. A comparison of infant mortality levels by age of women, urban-rural residence and birth order in table 15 shows that rural women generally have higher infant mortality rates. The figures refer to current and not childhood place of residence, and the real magnitude of the differentials is undoubtedly understated. This is true for both the older and younger women, although the differentials appear to have been reduced over time, ie they are less for the younger and more recently parturient women.

Cross-tabulations of urban-rural residence and educational attainment in tables 16 and 17 clarify the importance of the two factors as independent predictors of infant and child mortality. This clarification is necessary as the urban population is significantly more educated and, *ceteris paribus*, would be expected to have lower infant and child mortality. For the younger women, it appears that both urbanization and higher education act independently in lowering the infant mortality rate. Among the older women, the differentials by education are substantial, but there does not appear to be any independent urban-rural effect. The lack of differentials may be related to the likelihood that many of the older urban women spent a substantial

Table 14 Neo-Natal Deaths as Percentage of Infant Deaths by Educational Attainment and Current Age of Mother

Current age of mother	No education	Primary	Secondary or higher	All education levels
Under 30	46.7	47.3	45.9	46.9
	(347)	(353)	(37)	(738)
30 and over	39.3	46.3	–	41.4
	(1680)	(628)	–	(2321)

NOTE: Numbers of infant deaths are given in parentheses.

Table 15 Infant Mortality Rates by Current Urban-Rural Residence, Current Age of Mother and Birth Order

Birth order and current age of mother	Rural	Other urban	Nairobi/Mombasa
Birth order one			
Under 30	113.6 (2316)	71.0 (155)	89.1 (258)
30 and over	153.7 (2869)	117.6 (85)	137.9 (145)
Birth order two			
Under 30	89.0 (1686)	101.9 (108)	82.9 (181)
30 and over	109.9 (2794)	88.6 (79)	44.8 (134)
Birth order three			
Under 30	91.8 (1144)	69.4 (72)	79.6 (113)
30 and over	102.4 (2695)	83.3 (72)	72.6 (124)

NOTE: Numbers of births are given in parentheses.

Table 16 Infant Mortality Rates by Educational Attainment, Urban-Rural Residence and Current Age of Mother

Current age of mother and residence	No education	Primary	Secondary or higher	All education levels
Under 30				
Rural	113 (2812)	94 (3220)	76 (359)	101 (6402)
Urban	94 (315)	88 (558)	49 (205)	82 (1078)
30 and over				
Rural	120 (13382)	87 (6619)	49 (126)	108 (20155)
Urban	114 (703)	88 (596)	23 (97)	97 (1408)

NOTE: Numbers of births are given in parentheses.

Table 17 Childhood Mortality Rates During First Five Years of Life,[a] by Educational Attainment, Urban-Rural Residence and Current Age of Mother

Current age of mother and residence	No education	Primary	Secondary or higher	All education levels
Under 30				
Rural	204 (1467)	164 (1474)	117 (115)	181 (3055)
Urban	171 (167)	138 (266)	79 (76)	140 (510)
30 and over				
Rural	205 (11473)	147 (5500)	39 (96)	185 (17094)
Urban	172 (624)	122 (511)	50 (76)	144 (1222)

[a]Deaths during first five year of life per 1000 births.
NOTE: Numbers of births are given in parentheses. Sample limited to births five or more years preceding survey date.

part of their childbearing years in rural areas. In general, it may be concluded that increasing education has a much more substantial effect on infant mortality than does urbanization.

It is of some importance to note that, whereas urban residence has only a modest impact on infant mortality, its effect on childhood mortality (during the first five years of life) is substantial. For both older and younger women, the urban-rural differentials in child mortality within educational groups is notable. This probably reflects the greater importance of environmental factors in mortality in the years after infancy.

3.4 MONOGAMY, POLYGAMY AND INFANT MORTALITY

There has been some discussion in the literature about the possible association between infant mortality and type of marriage, but the strength of the association is a matter

Table 18 Infant Mortality Rates during the Past Decade (12–119 Months Ago), by Educational Attainment, Type of Marriage and Current Age of Mother

Educational attainment	Under 30			30 and over		
	Monogamous	Polygamous	Not currently married	Monogamous	Polygamous	Not currently married
No education	95 (1723)	128 (815)	116 (218)	90 (3196)	111 (1631)	104 (440)
Primary	79 (2453)	145 (633)	82 (408)	68 (2224)	70 (664)	81 (205)
Secondary or higher	77 (393)	32 (68)	57 (92)	19 (86)	87 (29)	–
All education levels	85 (4572)	131 (1516)	89 (718)	80 (5514)	99 (2324)	96 (648)

NOTE: The table excludes births occurring within 12 months of the survey date. Numbers of births are given in parentheses.

of doubt. Infants in a polygamous union may receive less attention than children in a monogamous marriage, and it is possible that their general level of well-being may be lower and their potential for survival somewhat reduced. Since polygamous marriages are associated with more traditional childbearing practices, there may be some significant association between polygamy and infant mortality. Finally, women in polygamous unions may on the average have less education than monogamous wives and for this reason have somewhat higher infant mortality. Table 18 shows clearly that less educated women in polygamous unions have a greater probability of infant mortality than monogamous women, regardless of their age. In order to reduce the likelihood that the births precede entry into a polygamous union, the tabulation is limited to infant deaths during the preceding decade. Polygamous women under the age of 30 who have no education have infant mortality rates over the preceding decade of 128, compared with only 95 for their counterparts in monogamous marriages. The differential is also considerable for older women. Over all educational levels, the differential between monogamous and polygamous women is large. Of course, this association between infant mortality and polygamy is confounded by the fact that the tropical regions of Kenya, with their attendant health risks to infants, are also the areas where polygamy is most prevalent. Though the reasons for the differential remain uncertain, it is clear that these are significant differentials in infant mortality between women in different types of marriages, even after controlling for educational differences.

3.5 REGIONAL DIFFERENCES IN INFANT MORTALITY

Apart from provincial differences in infant mortality which may be due to differences in demographic characteristics of women resident in different areas, there can also be substantial regional variations in infant mortality due to factors such as climate, nutrition and access to health services. Thus, it is not surprising to find significant variations in infant mortality between the different provinces in Kenya (table 13). For both older and younger women, infant survival probabilities are extremely poor in Nyanza province. Historically, infants on the Coast had the poorest survival prospects, although the infant mortality rate for births to women under the age of 30 suggests some recent improvement. Western province has significantly above-average infant mortality, while children in Central province, the Rift Valley and Nairobi have the best survival prospects. Generally, these results are consistent with the provision of health care services in Kenya. Nairobi is an urban area, and Central and Rift Valley provinces have relatively good access to health care and above-average nutrition, and are also above average in the educational attainment of their population. On the other hand, the two provinces on the Western boundary of Kenya as well as the Coast province are the most tropical parts of Kenya. Malaria is endemic to parts of these provinces and in general, tropical diseases are more common in these areas.

In Nyanza and the Western province the proportion of infant deaths occurring during the first month (for women over 30) is lower than elsewhere (table 19), supporting our suggestion that the infant deaths in high risk areas are of environmental origin. The extremely high neo-natal mortality rate in the Coast province is difficult to explain. The extent to which geographical variations in infant mortality remain after controlling for other demographic and socio-economic factors are now considered.

Table 19 Neo-Natal Deaths as Percentage of Infant Deaths, by Province, Urban-Rural Residence and Current Age of Mother

Current age of mother	Nairobi	Central	Coast	Nyanza	Rift	Western	Eastern	Urban	Rural
Under 30	40.0 (35)	50.9 (55)	59.0 (90)	29.8 (238)	46.7 (120)	48.6 (138)	52.0 (100)	45.7 (94)	44.0 (689)
30 and over	36.7 (60)	43.3 (300)	52.0 (229)	29.9 (857)	44.8 (328)	34.8 (351)	44.4 (374)	45.1 (144)	38.0 (2354)

NOTE: Numbers of infant deaths are given in parentheses.

4 Trends and Differentials in Infant and Neo-Natal Mortality: A Multivariate Perspective

This paper has considered the differential importance of a number of factors in determining the level of infant mortality and its pattern in the first year of life. To some extent, we have clarified the relative importance of key variables as determinants of the level of infant mortality. However, there are a number of questions which can be best answered through the use of a multivariate regression framework. First, to what extent are province of residence, educational attainment, urban residence, polygamous marriage, or the order of a birth significant independent predictors of infant or post-neonatal mortality? Secondly, to what extent are the different factors of greater or lesser importance as determinants of mortality now, compared with one or two decades ago?

When all of these factors are included in one regression where the dependent variable is whether an infant survives the first year of life, it may be seen that, with the exception of current urban-rural residence,[6] they are statistically significant determinants (see table 20). Consistent with the tabular results, residence in the Coast, Nyanza and Western provinces is associated with above-average infant mortality, even after controlling for the demographic and other socio-economic variables. Age of mother at birth and birth order are also significant independent variables; we know from other analyses that it is the babies of the very young mothers, parity one births, or high parity births that are most at risk. In addition, the regression coefficients suggest that the more education the mother has, the lower the probability of the infant dying during the first year; and independent of mother's education and other factors, children of women in polygamous unions are more likely to die. The table also shows that males are significantly less likely to survive the first year.

Perhaps most importantly, births during recent years are more likely to survive than births further in the past, even after controlling for all the demographic factors. In other words, the decline in infant mortality over time, while due partly to changing demographic or social composition, cannot be solely attributed to increased education, urban residence, or the declining prevalence of polygamy.

Table 20 shows that a number of the factors are significant determinants of both recent and past infant mortality. In the three periods specified, living in the Coast, Nyanza and the Western provinces was associated with above-average infant mortality.

Similarly, young maternal ages, no education, and polygamous marital status are significant determinants of infant mortality now and in the past. On the other hand, the sex of the child and the order of the birth seem to be more important now than previously. To some extent, these differential trends may be statistical anomalies. The larger sample sizes in the models for recent periods make it more likely that the coefficients in these models will attain statistical significance, even where the coefficients themselves may not be large.

From table 21, it is apparent that some of the results for the post-neonatal model parallel the overall infant mortality results. The post-neonatal prediction models are limited to the sample of infant deaths where the dependent variable is whether an infant death was post-neonatal (dying at 2–12 months) or neo-natal (dying in the first month of life).

The Coast, Nyanza and Western provinces, which are associated with above-average infant mortality, are also provinces where infant deaths occurred disproportionately after the first month, following the pattern that areas with a poorer environment are more likely to have environmentally caused infant deaths. This situation, which has always existed in these provinces in the past, continues to prevail.

It may be also noted from the regressions that a higher level of education is significantly associated with a higher proportion of neo-natal deaths. Once births to better educated women survive the first few weeks of life, their chances of surviving infancy are quite good. Their likelihood of an environmentally caused death is far below that of the children whose mothers have no education.

As shown earlier in table 10 the dominant reason for the above-average male infant mortality is their above-average neo-natal mortality rate.

Independent of education, there is some evidence that infant deaths to polygamous women are more likely to be neo-natal. The reason for this is unclear, but it certainly refutes the argument that young children in polygamous households have above-average mortality probabilities because of less care and attention in the post-neonatal infant phase.

Finally, there is some evidence that very low and very high order births are more likely to die in the neo-natal period (compared with parity two, three and four), both now and in the past. Also, evidence is conclusive that the proportion of infant deaths occurring in the post-neonatal period was lower ten and twenty years ago than now.

The factors which determine infant and post-neonatal mortality have their greatest impact as determinants of death after the first birth. Only region of residence and the age of the woman at the birth are significant determinants of infant mortality at all parity levels, as shown in table 22. In general, socio-economic and demographic factors have little influence on infant mortality at intermediate birth orders. The lower importance of the variables at the higher orders undoubtedly results from the smaller sample sizes in these models and the larger standard errors for the coefficients, thus making it more difficult for the regression

[6] One explanation for the lack of significance of the urban-rural variable is that it relates to current residence, whereas the infant's death may have occurred at a time when the woman was living in a different area.

Table 20 Determinants of Infant Mortality by Period of Birth: Regression Results

	All births		1968–76		1958–67		Pre-1958	
	Coefficient	(t-value)	Coefficient	(t-value)	Coefficient	(t-value)	Coefficient	(t-value)
Coast/Nyanza/Western residence	.044	(12.00)[a]	.049	(10.12)[a]	.040	(6.35)[a]	.042	(3.37)[a]
Age at birth	– .003	(7.20)[a]	– .0018	(3.50)[a]	– .0038	(5.42)[a]	– .0095	(5.32)[a]
Primary school	– .021	(5.45)[a]	– .015	(3.00)[a]	– .023	(3.53)[a]	– .034	(2.47)[a]
Secondary school	– .048	(4.19)[a]	– .036	(2.97)[a]	– .082	(2.71)[a]	– .093	(1.06)
Male birth	.012	(3.45)[a]	.010	(2.23)[b]	.018	(2.88)[a]	.0080	(0.67)
Urban residence	– .0068	(1.04)	– .0001	(0.12)	– .0099	(0.83)	– .033	(1.32)
Polygamy	.016	(3.85)[a]	.016	(2.83)[a]	.013	(1.86)[b]	.022	(1.67)[b]
Birth order one	.019	(3.76)[a]	.016	(2.18)[b]	.015	(1.77)[b]	.011	(0.79)
Birth order 5–9	.023	(4.38)[a]	.018	(2.74)[a]	.030	(3.51)[a]	– .018	(0.83)
Birth order 10+	.077	(6.50)[a]	.056	(4.32)[a]	.123	(4.17)[a]	.288	(1.15)
Birth 1968–76	– .048	(8.06)[a]	*		*		*	
Birth 1958–67	– .039	(6.60)[a]	*		*		*	
Constant	.183		.103		.165		.328	
R^2 (ADJ)	.018		.012		.012		.019	
F ratio	44.47[a]		19.83[a]		13.84[a]		8.17[a]	
N	29 141		15 251		10 187		3703	

[a]Significant at 1 per cent level (one tail test).
[b]Significant at 5 per cent level.
*Not included in equation.

Definitions of variables used in regression analyses

Coast/Nyanza/Western residence 1 = lives there, 0 = live elsewhere
Age at birth Continuous variable of age of mother at birth of child (in years)
Primary school 1 = completed some primary school, 0 = other
Secondary school 1 = completed some secondary school, 0 = other
Male birth 1 = birth was male, 0 = was female
Urban residence 1 = survey residence was urban, 0 = other
Polygamy 1 = mother is polygamous at survey, 0 = other
Birth order one 1 = first birth, 0 = other
Birth order 5–9 1 = birth was parity 5–9, 0 = other
Birth order 10 plus 1 = birth was parity 10 or above, 0 = other
Birth 1968–76 1 = birth 13–119 months ago, 0 = other
Birth 1958–67 1 = birth 120–239 months ago, 0 = other
Birth pre-1958 1 = birth 240 months or more ago, 0 = other
Infant mortality 1 = infant died, 0 = infant survived
Post-neonatal mortality 1 = infant died months 2–12, 0 = infant died first month

Table 21 Determinants of Post-Neonatal Infant Mortality by Period of Birth: Regression Results

	All infant deaths		1968–76		1958–67		Pre-1958	
	Coefficient	(t-value)	Coefficient	(t-value)	Coefficient	(t-value)	Coefficient	(t-value)
Coast/Nyanza/Western residence	.097	(5.22)[a]	.076	(2.70)[a]	.115	(3.71)[a]	.120	(2.94)[a]
Age at birth	.0015	(0.74)	.0046	(1.66)[c]	– .0063	(1.82)	.0056	(1.01)
Primary school	– .043	(2.22)[b]	– .016	(0.57)	– .050	(1.51)	– .096	(2.07)[b]
Secondary school	– .093	(1.25)	– .077	(0.96)	– .236	(0.91)	– .325	(0.54)
Male birth	– .078	(4.42)[a]	– .111	(4.18)[a]	– .059	(1.98)[b]	– .027	(0.70)
Urban residence	– .022	(0.63)	– .020	(0.43)	– .066	(1.05)	– .091	(1.05)
Polygamy	– .050	(2.61)[a]	– .042	(1.42)[c]	– .022	(0.69)	– .122	(2.94)[a]
Birth order one	– .080	(3.37)[a]	– .073	(1.80)[b]	– .106	(2.65)[a]	– .057	(1.30)[c]
Birth order 5–9	– .062	(2.36)[a]	– .080	(2.08)[b]	.0057	(0.14)	– .213	(2.40)[a]
Birth order 10+	– .127	(2.29)[b]	– .135	(1.94)[b]	– .145	(1.26)	– .825	(1.47)[c]
Birth 1968–76	– .077	(2.92)[a]	*		*		*	
Birth 1958–67	– .064	(2.50)[a]	*		*		*	
Constant	.659		.519		.737		.581	
R^2 (ADJ)	.021		.016		.027		.032	
F ratio	7.36[a]		3.27[b]		4.02[a]		2.99[b]	
N	3069		1383		1090		596	

NOTE: Dependent variable is 1 if infant died during months 2–12 and 0 if infant died during the first month of life.

Table 22 Determinants of Infant Mortality by Birth Order: Regression Results

	Birth order 1		Birth order 2		Birth order 5		Birth order 7	
	Coefficient	(t-value)	Coefficient	(t-value)	Coefficient	(t-value)	Coefficient	(t-value)
Coast/Nyanza/Western residence	.051	(5.57)[a]	.030	(3.45)[a]	.051	(4.65)[a]	.018	(1.30)[c]
Age at birth	– .0051	(4.15)[a]	– .0047	(4.09)[a]	– .0019	(1.48)[c]	– .0030	(1.89)[b]
Primary school	– .030	(3.14)[a]	– .0028	(0.31)	– .021	(1.89)[b]	– .017	(1.18)
Secondary school	– .073	(3.47)[a]	– .029	(3.02)[a]	– .013	(0.28)	– .103	(1.22)
Male birth	.015	(1.69)[b]	.0095	(1.13)	– .0016	(0.15)	.069	(5.02)[a]
Urban residence	– .015	(0.98)	– .014	(0.97)	– .013	(0.62)	*	–
Polygamy	.0035	(0.34)	.041	(4.16)[a]	.0071	(0.59)	.018	(1.20)
Birth 1968–76	– .064	(5.35)[a]	– .041	(3.47)[a]	– .029	(1.29)[c]	.081	(1.66)[c]
Birth 1958–67	– .052	(4.44)[a]	– .036	(3.02)[a]	– .016	(0.70)	.061	(1.24)
Constant	.257		.203		.153		.075	
R^2 (ADJ)	.023		.015		.011		.017	
F ratio	16.20[a]		9.80[a]		4.58[a]		4.78[a]	
N	5895		5048		3002		1798	

NOTE: Dependent variable is 1 if infant died during past year and 0 otherwise.

Footnotes to tables 21 and 22

[a]Significant at 1 per cent level (one tail test). [b]Significant at 5 per cent level. [c]Significant at 10 per cent level. *Not included in equation.

coefficients to attain statistical significance. We may conclude that low order births in the distant past were significantly less likely to survive than order one or two births are now. This temporal effect is not evident at the intermediate levels, strongly suggesting that a disproportionate part of the recent decline in infant mortality stems from reduction in mortality at lower orders. The result supports the tabulations presented in table 8. These regression results show that these disproportionate improvements at parity one and two are independent of other secular changes in educational attainment, urban-rural residence and polygamy status. In other words, the major causes for the decline in infant mortality are not demographic. The decline may be attributed to general improvements in access to health and medical services, nutrition, the quality of housing and personal hygiene.

Appendix A – Notes on the Application of the Brass Technique for Indirect Estimation of Infant and Child Mortality

Brass's estimation procedure was used in calculating the indirect estimate of infant mortality for the total population and the various subsets of the population. In this procedure q(1), mortality in the first year of life, is estimated from D1, the proportion dead among children ever born to women aged 15–19. Since the approximate equalities of q(1) and D1 are affected by variations in the age pattern of fertility, Brass has calculated a series of multipliers based on the ratios P1 to P2 and P2 to P3 which were applied to the various values of D1. Brass (1975) suggests that P2/P3 might be a more satisfactory parameter than P1/P2 'since P1 is sensitive both to age reporting errors at the start of child bearing and to sampling fluctuations due to relatively small numbers of births'.

Two sets of multipliers were used, the Brass standard and Brass African multipliers. These sets of multipliers differ from each other in that they were based on different shapes of mortality curves. The standard multipliers were based on the West family of model life tables and African multipliers were based on the North family model of life tables. In the North pattern of mortality, infant mortality is relatively low and childhood mortality (over age one) is relatively high. The largest deviations between the two sets of multipliers occur when fertility distributions, measured by P1/P2 and P2/P3 ratios, are extremely early or late.

Table A1 Distribution of the Female Population by Age and Other Selected Characteristics

	15–19	20–24	25–29
% with no education	17.6	30.7	44.6
% with no primary	63.6	50.7	46.4
% with no secondary	18.4	18.6	8.9
% urban	12.7	19.4	15.0
% rural	87.3	80.6	85.0
% in Nairobi	6.0	9.3	5.9
% in Central Prov.	15.7	12.4	14.3
% in Coast Prov.	6.9	9.4	10.5
% in Nyanza Prov.	21.2	21.2	19.5
% in Rift V. Prov.	17.8	19.0	20.2
% in West. Prov.	14.1	13.8	13.3
% in East Prov.	18.0	14.6	15.7

NOTE: Because of the inconsistency by age of woman in the distribution of the female population for selected characteristics, it is felt that the utilization of the indirect Brass techniques for subpopulations would in many instances be demographically incorrect. For example, it is clear from the above table that radical changes in the mix of the adult population by educational attainment are occurring. Thus, the 15–19 year old age cohort represents a much more 'selected out' group than the 20–24 group with no education. This could well lead to a radical distortion in the P1/P2 ratio for the no education group. For the interested reader, all the indirect mortality estimates are included in table A2.